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Using isotopes to validate GHG emission inventories

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Acknowledgements

CO_2 measurements

Students: Susan Bush, Sonja Djuricin

Collaborators: Jim Ehleringer, Dave Bowling, Xiaomei Xu

N_2O and CH_4 measurements

Postdoc: Amy Townsend-Small

Collaborators: Stan Tyler, Sue Trumbore

Plant isotope measurements

Students: Diana Hsueh, Wenwen Wang

Collaborators: Jim Randerson, Bill Riley, Marc Fischer

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What are isotopes?

All CO_2 molecules are not alike



Average abundance:

^{12}C 98.89 %

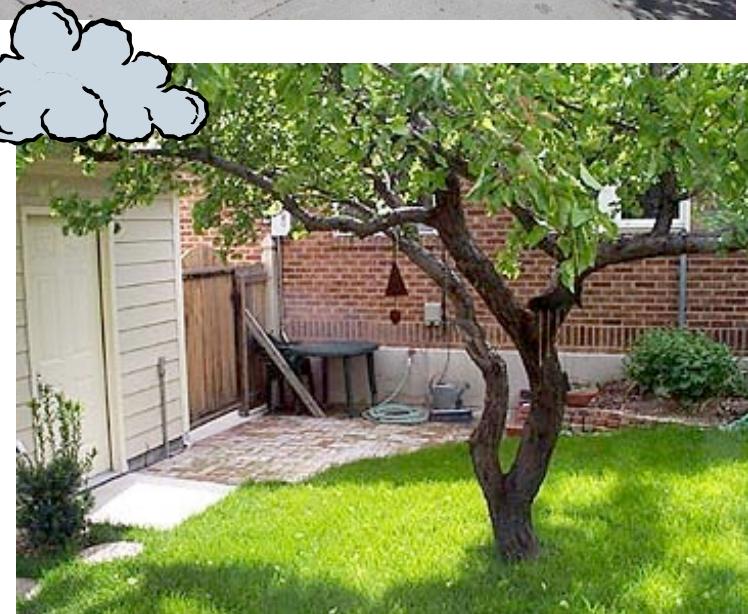
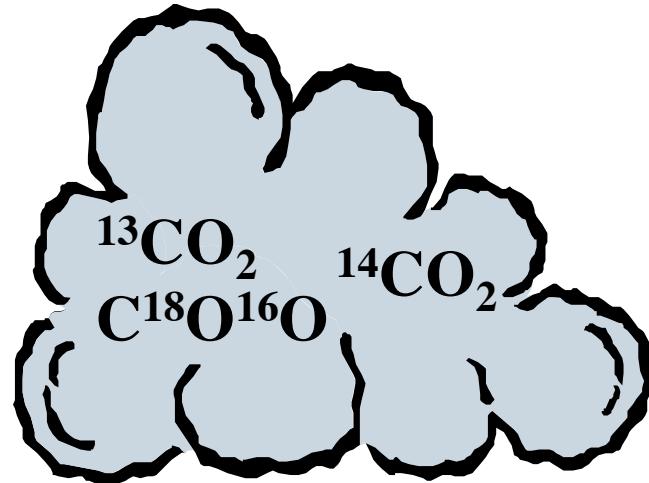
^{13}C 1.11 %

^{14}C < 10^{-10} %

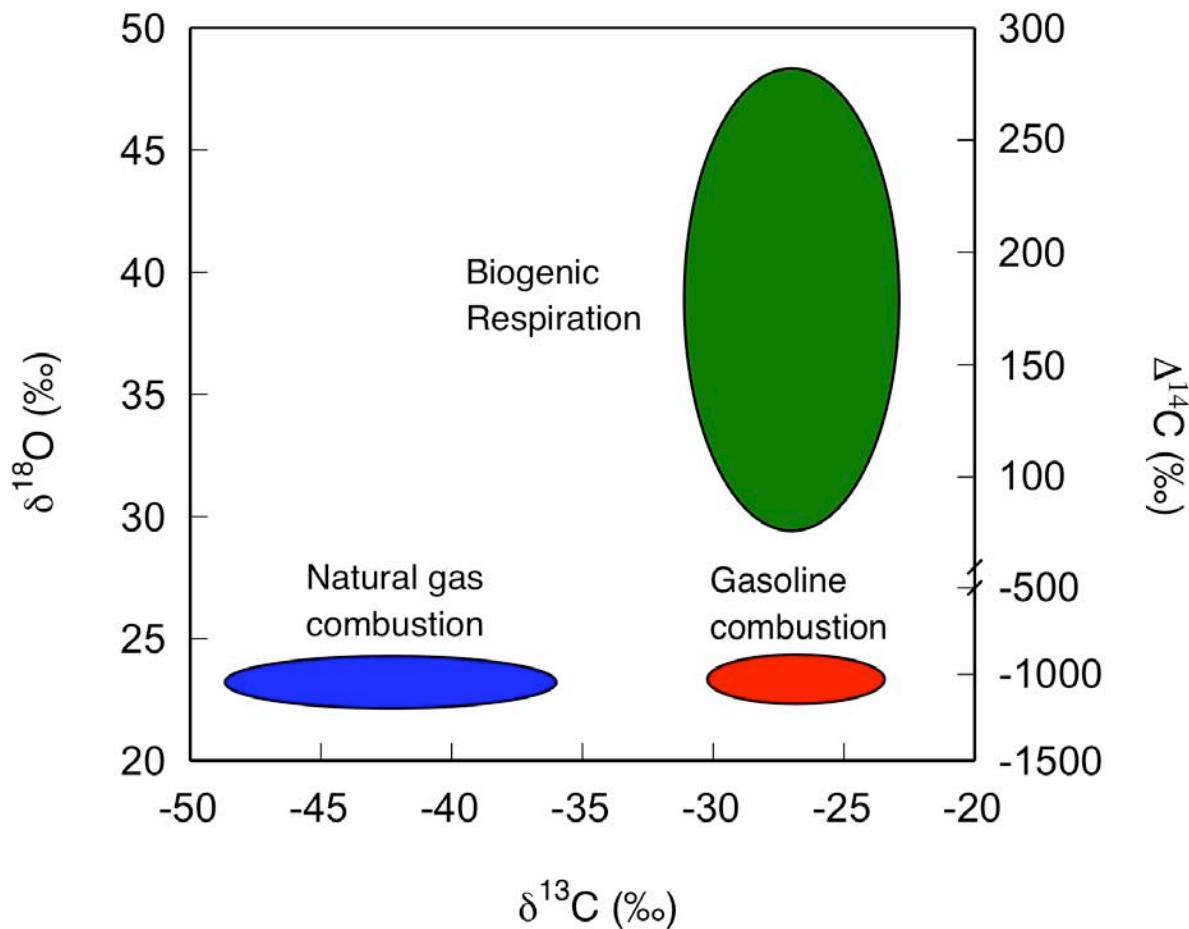
^{16}O 99.76 %

^{18}O 0.20 %

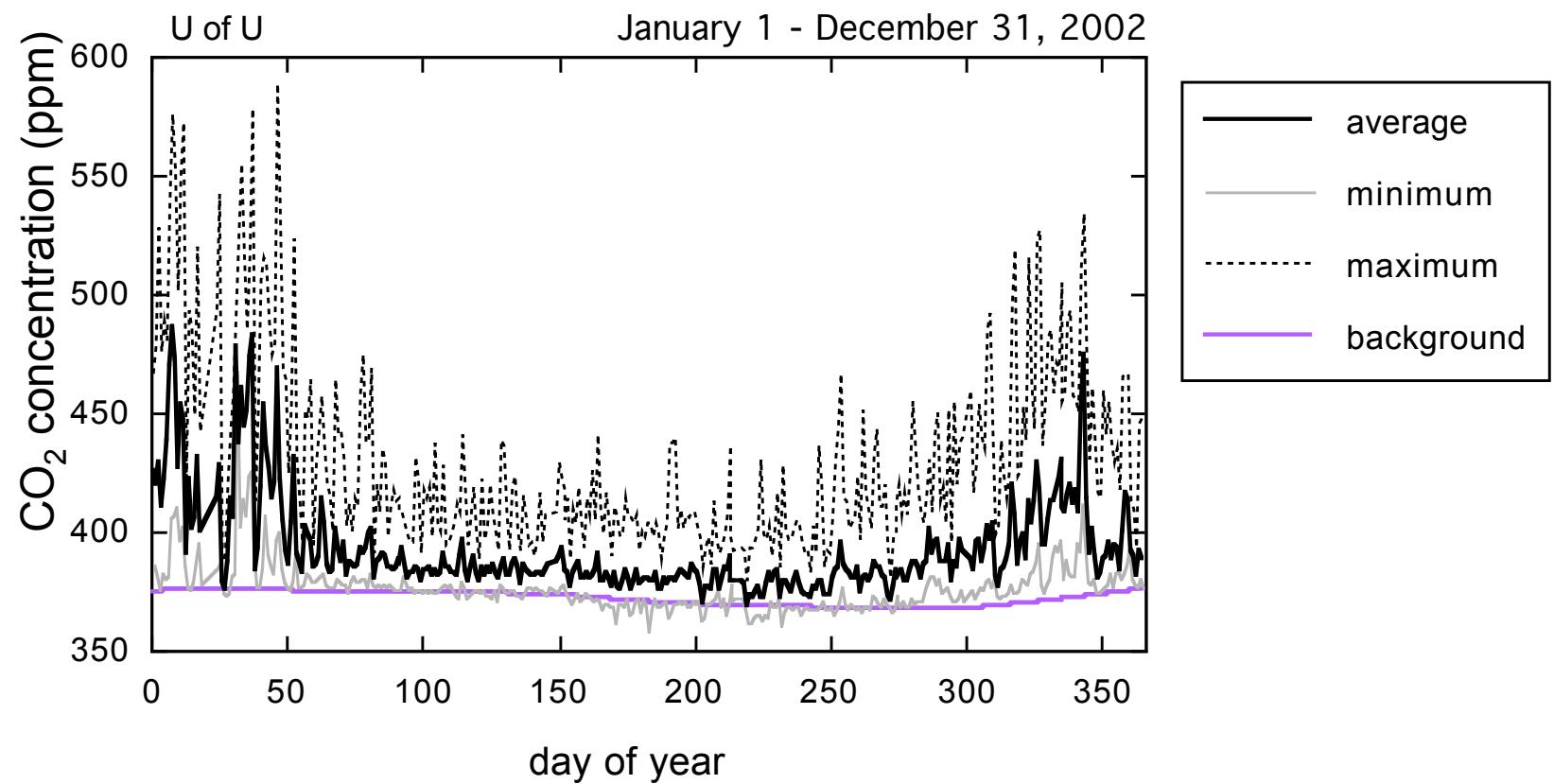
Atmospheric CO₂ sources have unique isotope signatures



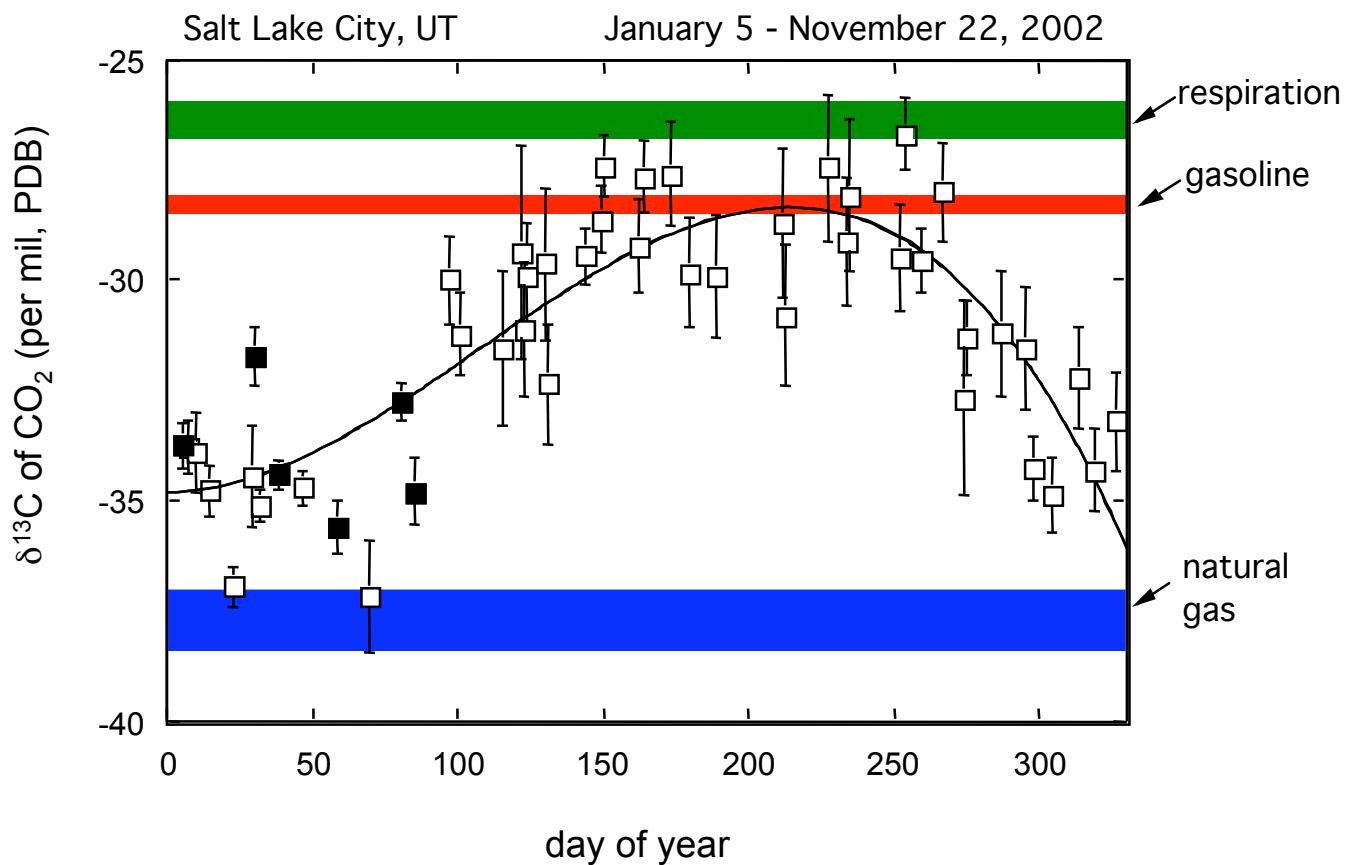
Atmospheric CO_2 sources have unique isotope signatures



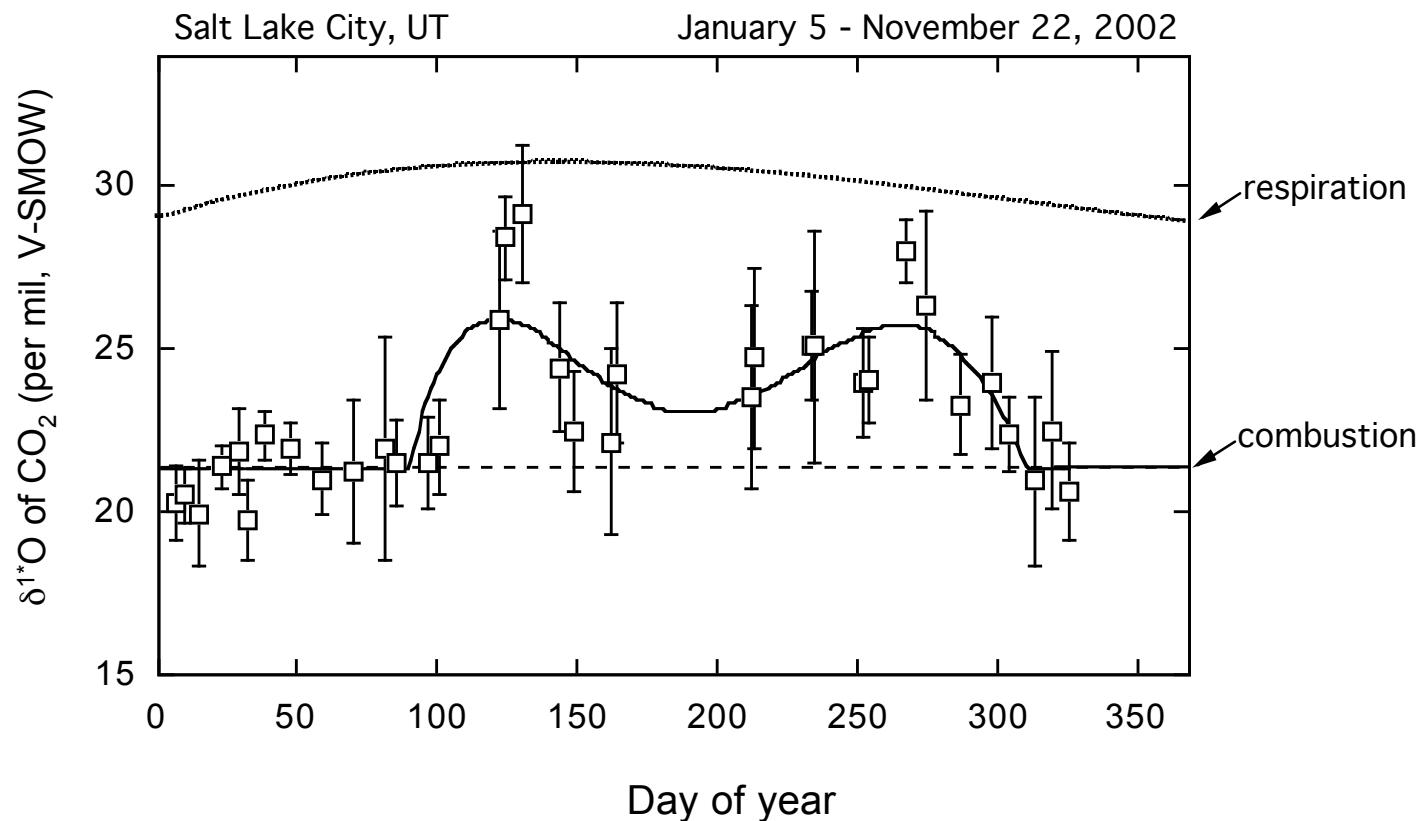
Urban CO_2 concentrations (Salt Lake City, Utah)



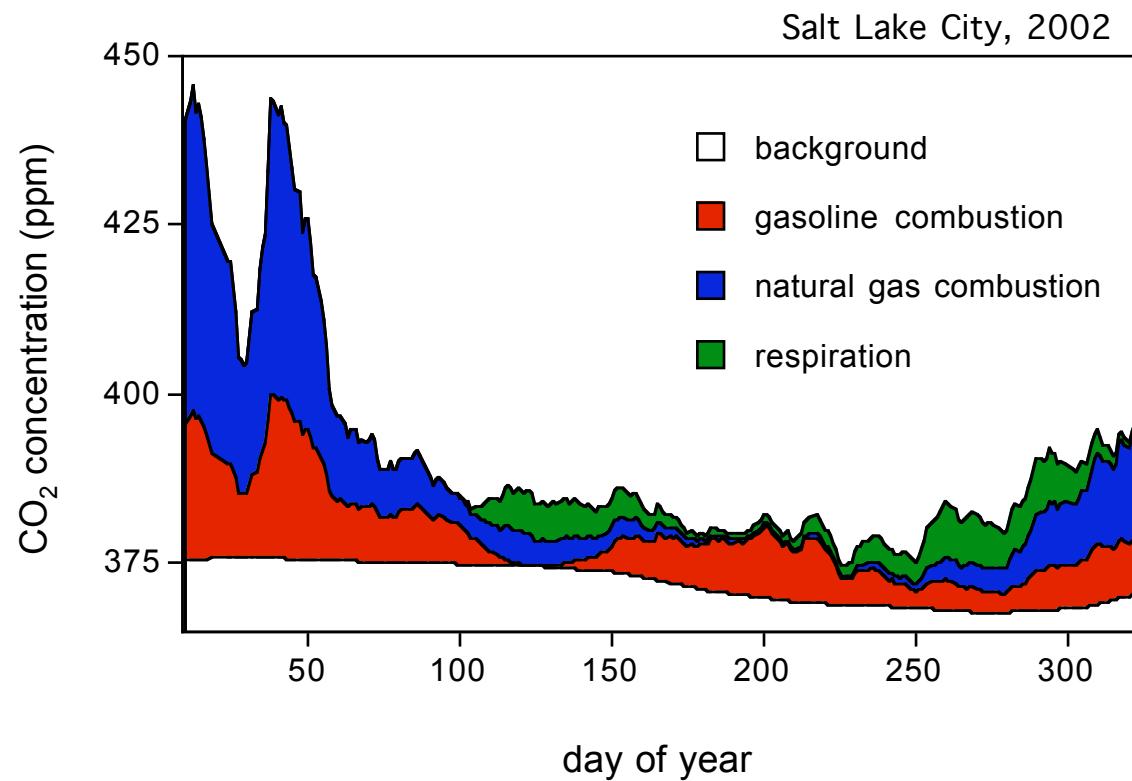
Stable carbon isotopes in local, non-background CO_2



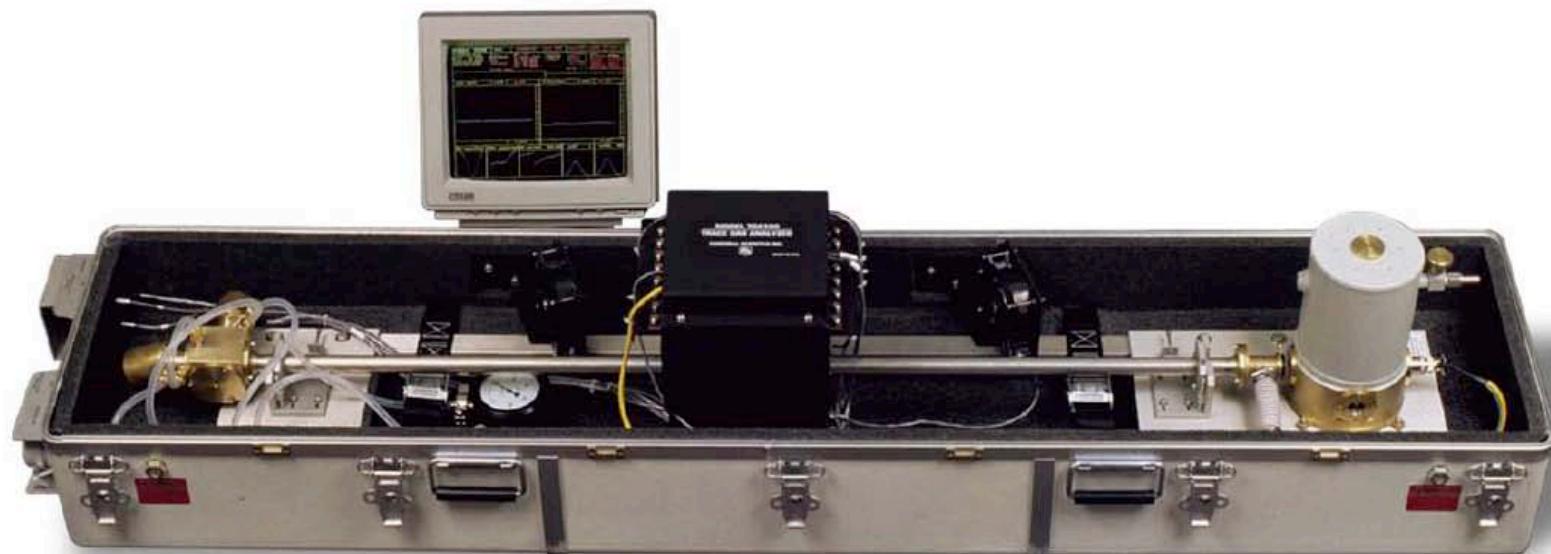
Stable oxygen isotopes in local, non-background CO_2



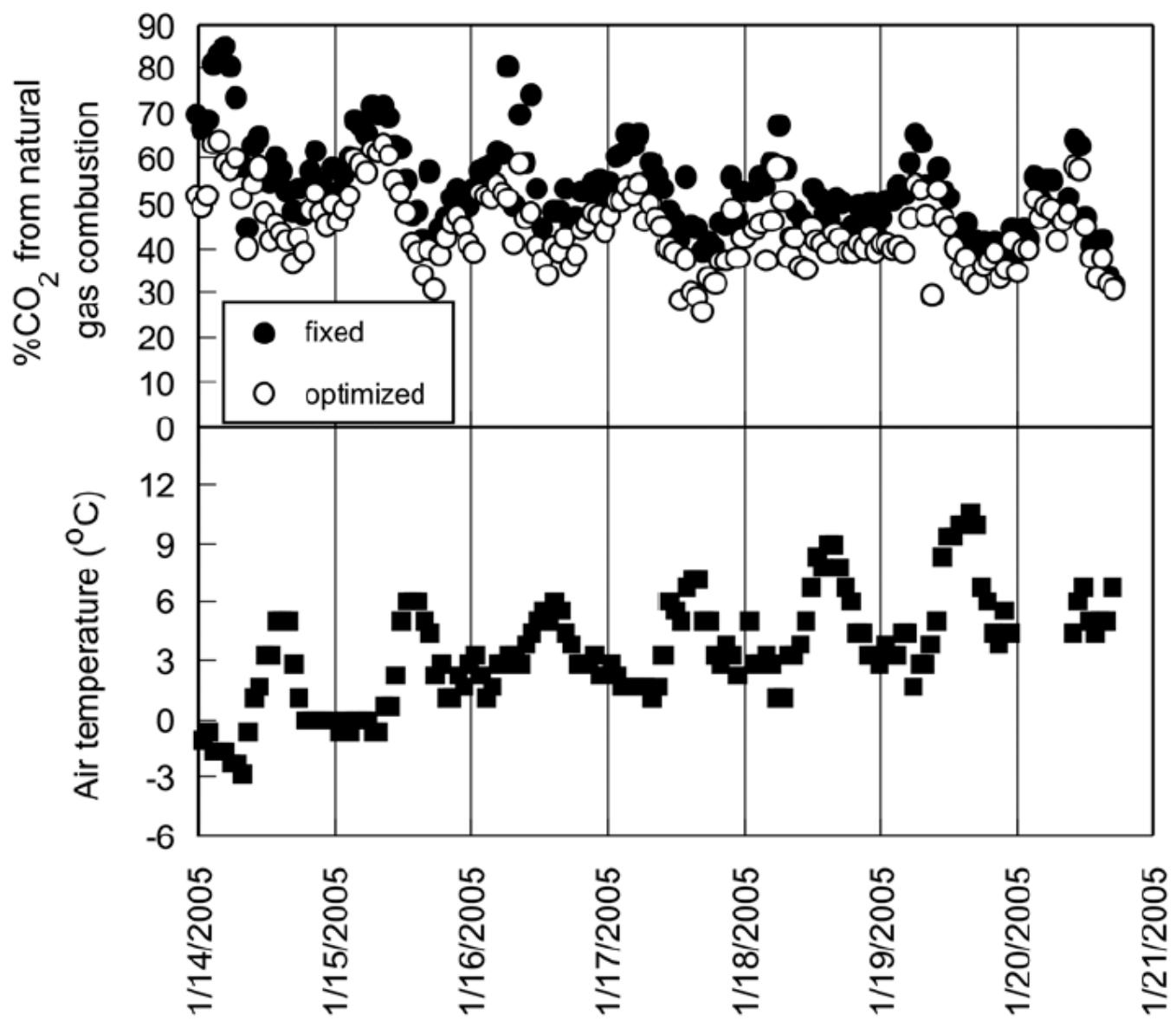
Solving for CO_2 sources with a mass balance approach



Emerging technology: Continuous measurements of isotopes in the atmosphere

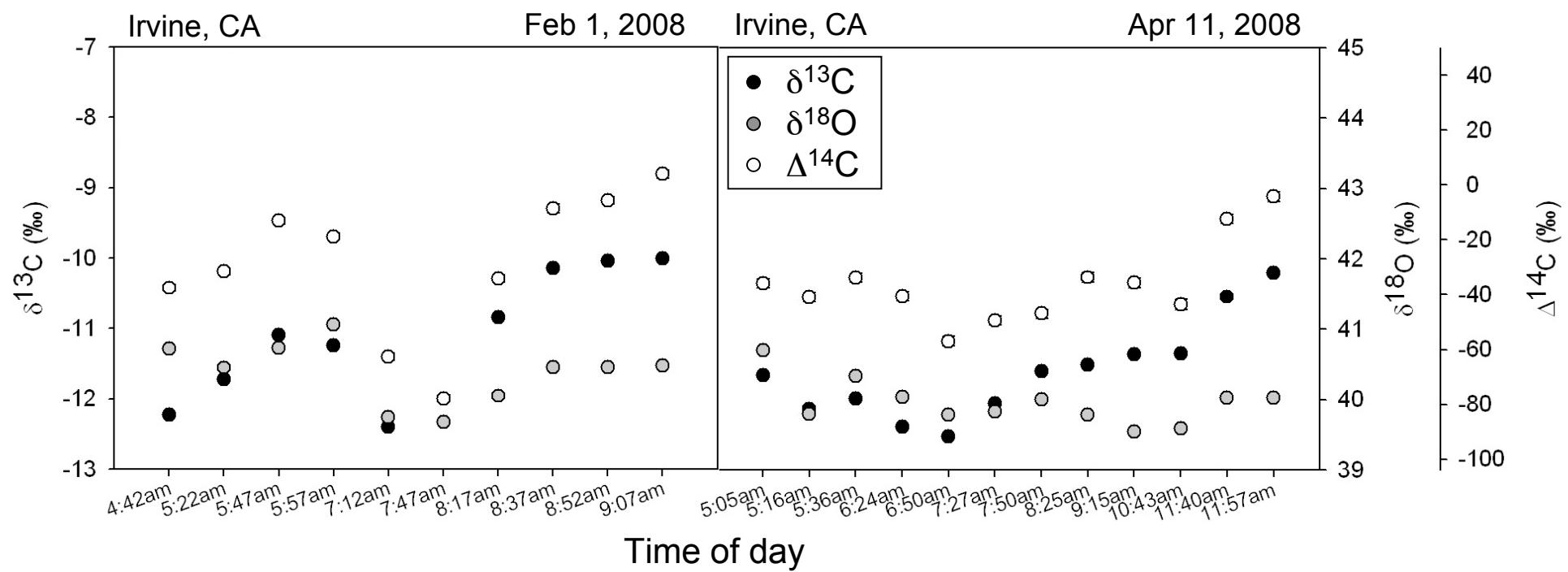


Tunable Diode Laser (TDL) absorption spectrometer

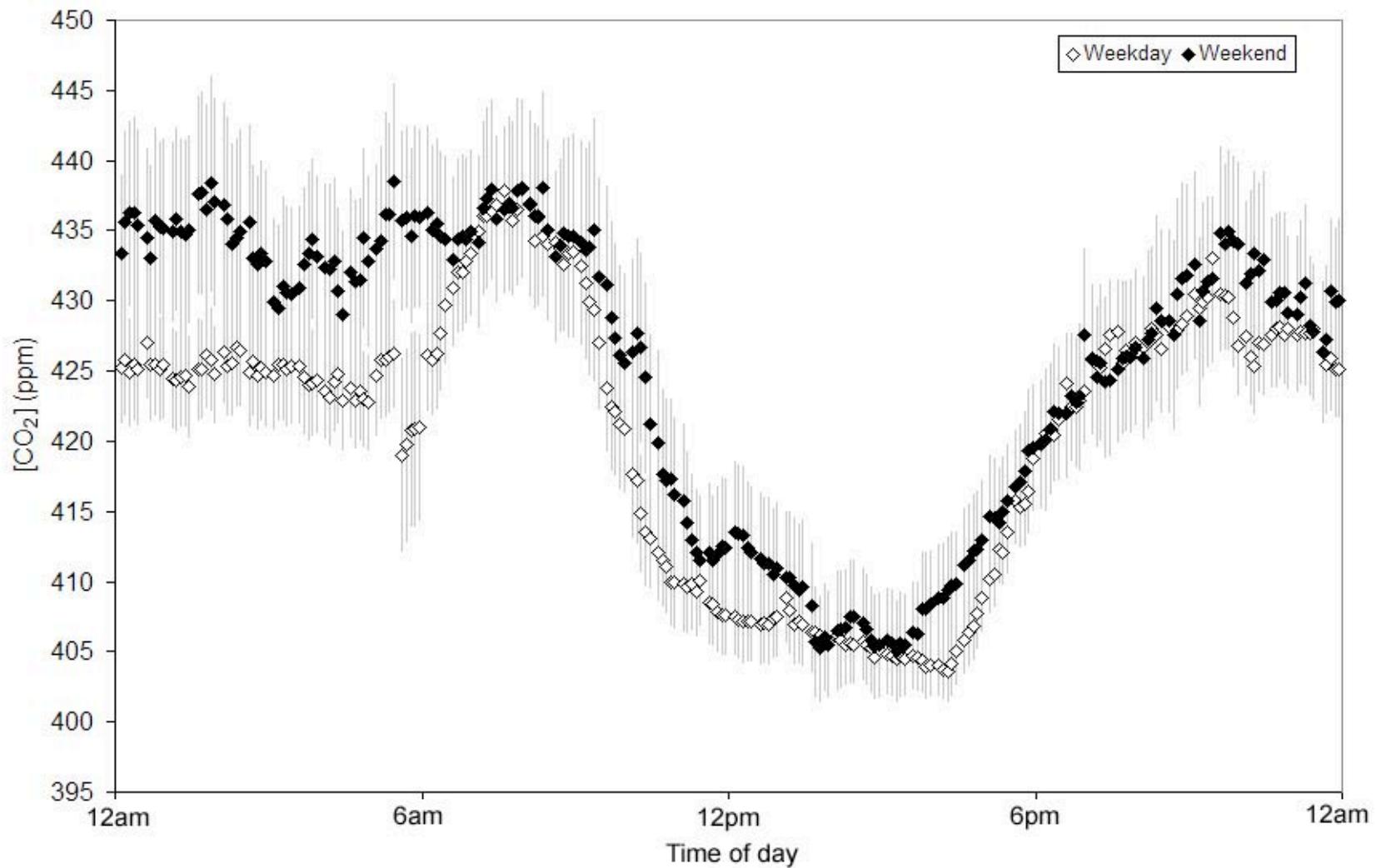


Pataki et al. 2006 Geophysical Research Letters v33

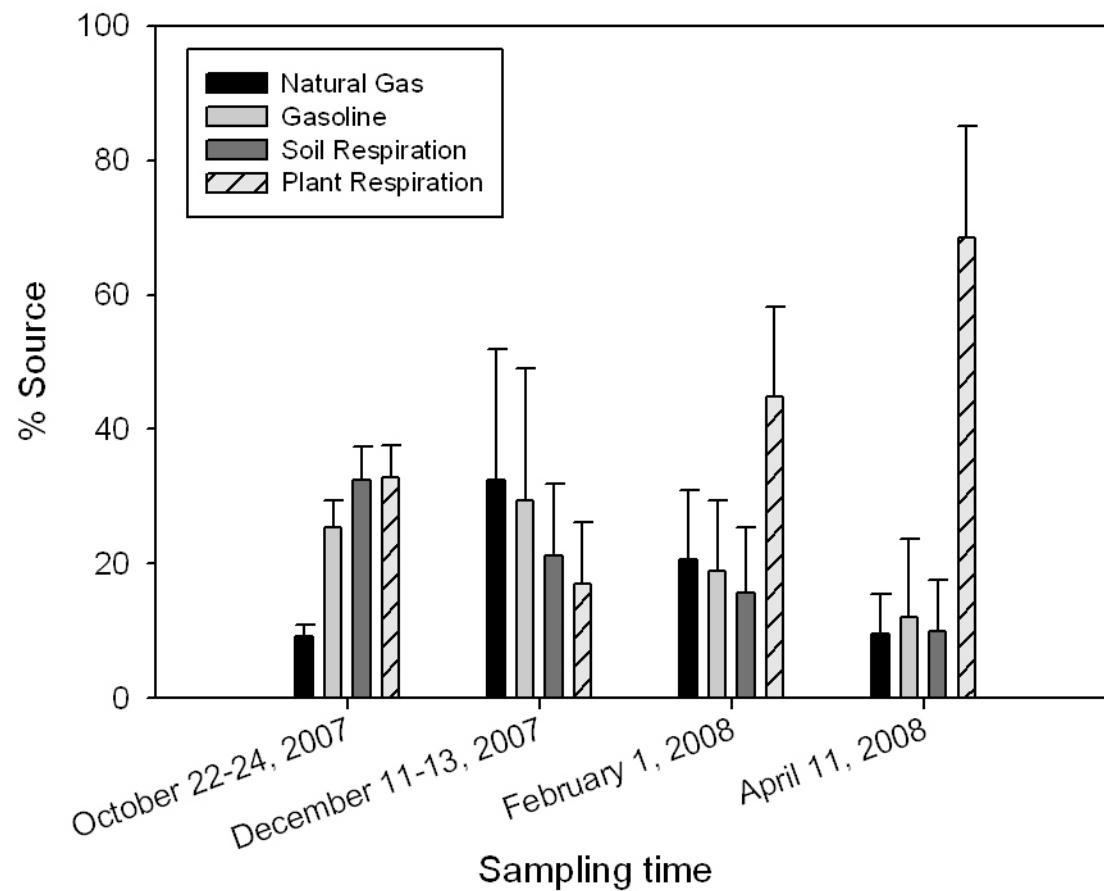
Combining the stable isotope and radiocarbon tracers

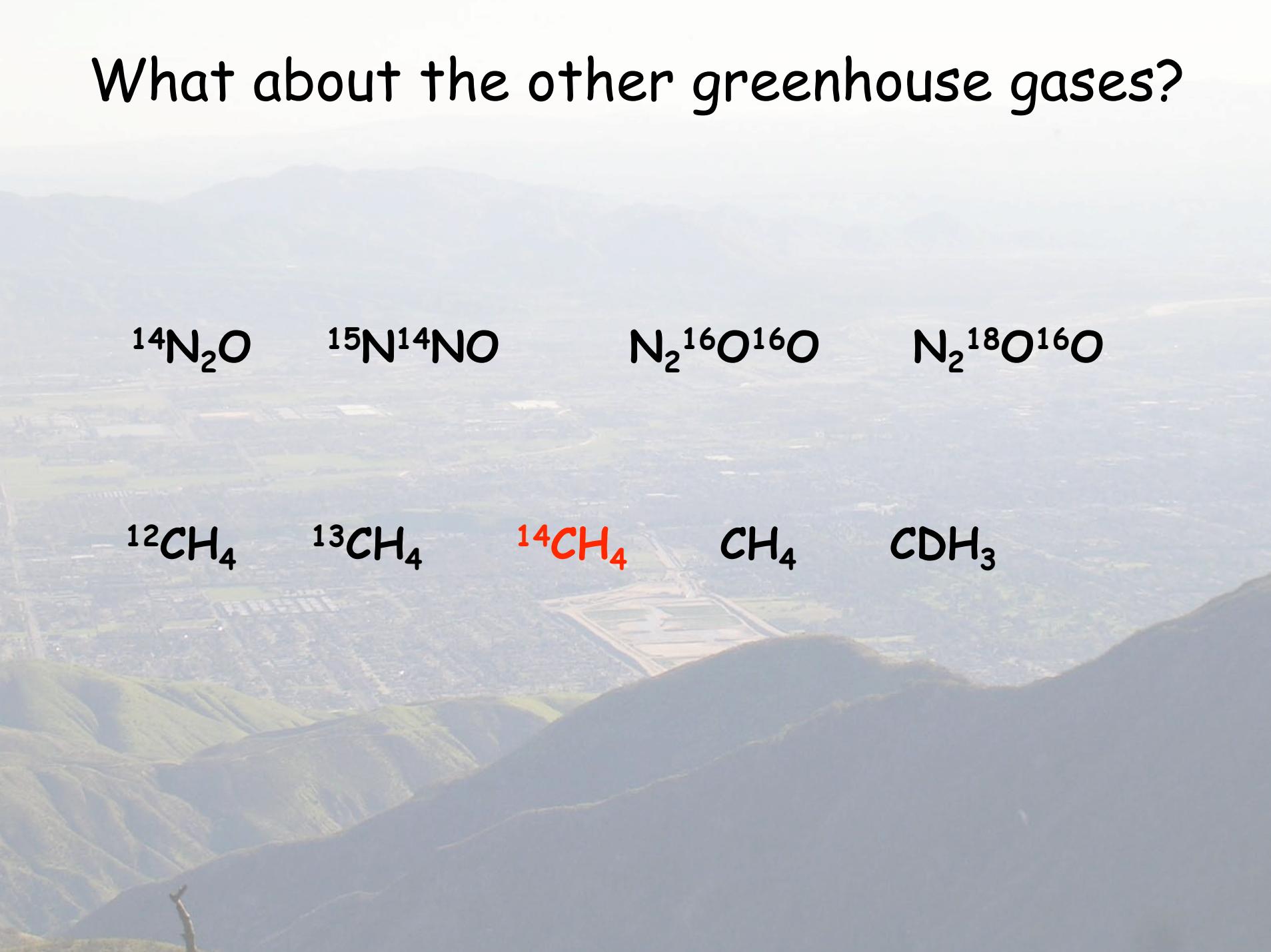


CO_2 concentrations in Irvine, CA

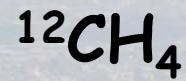
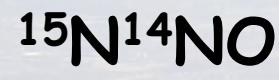


Combining all three isotope tracers improves source attribution

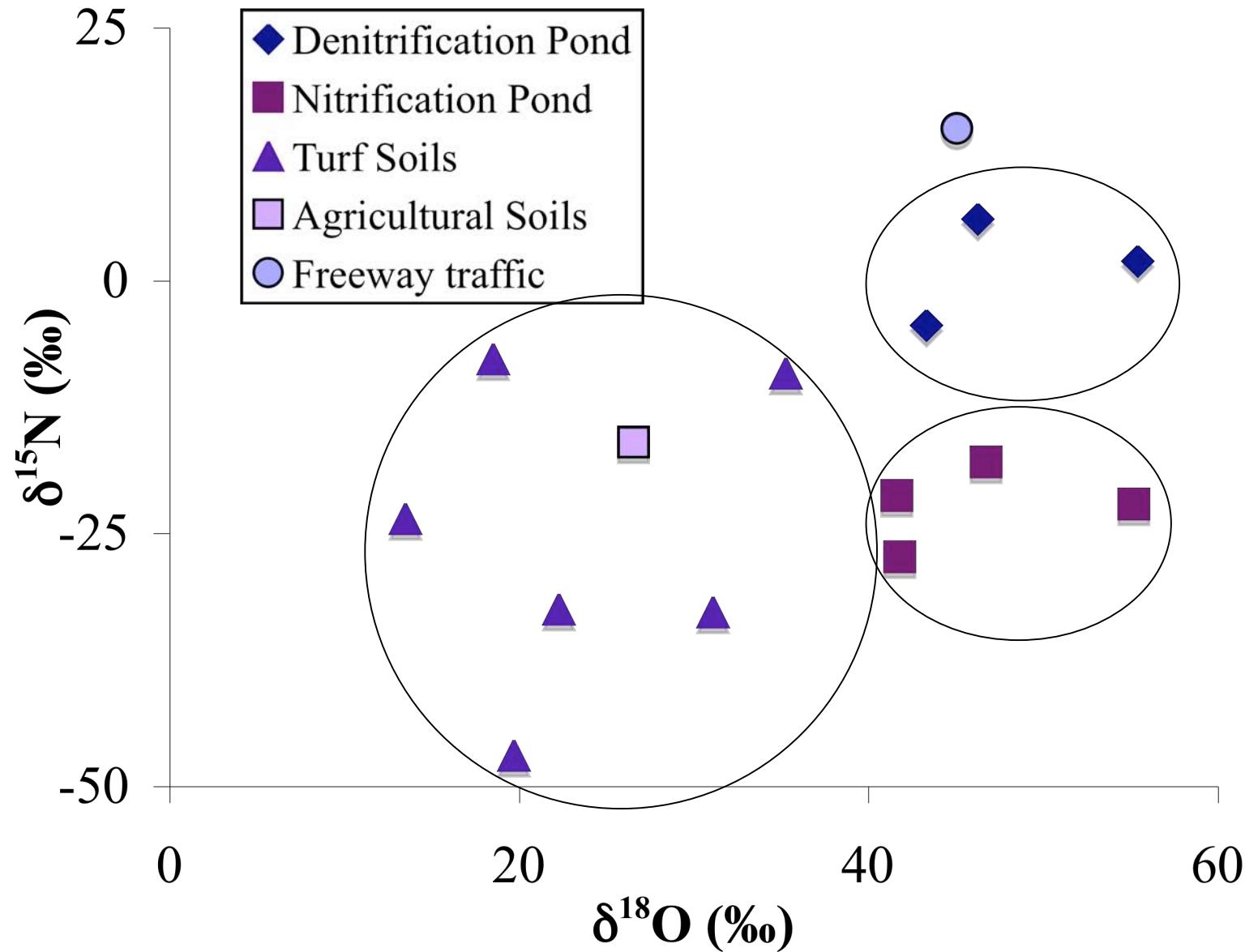




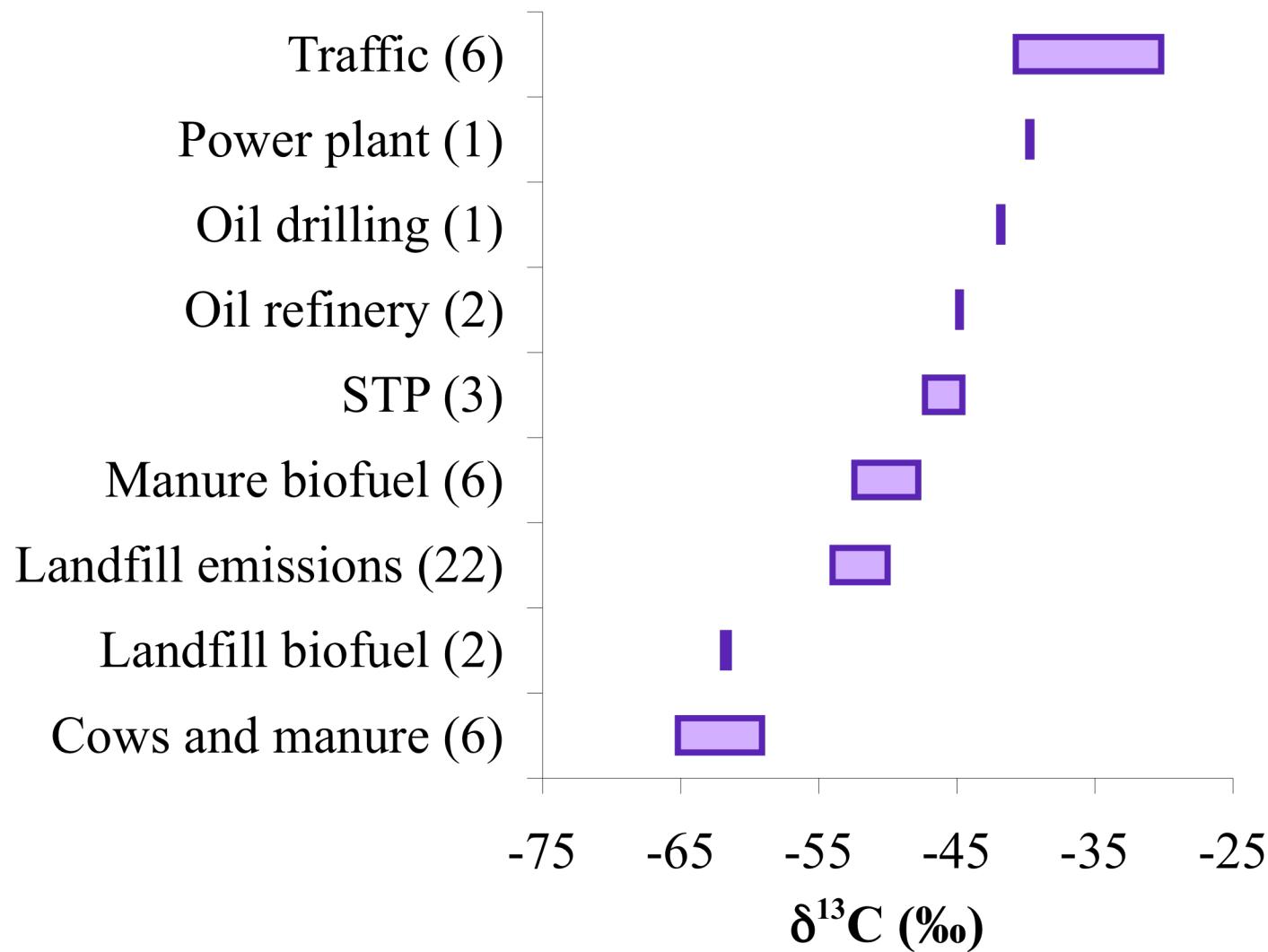
What about the other greenhouse gases?



Isotopically distinct N₂O sources in the LA Basin



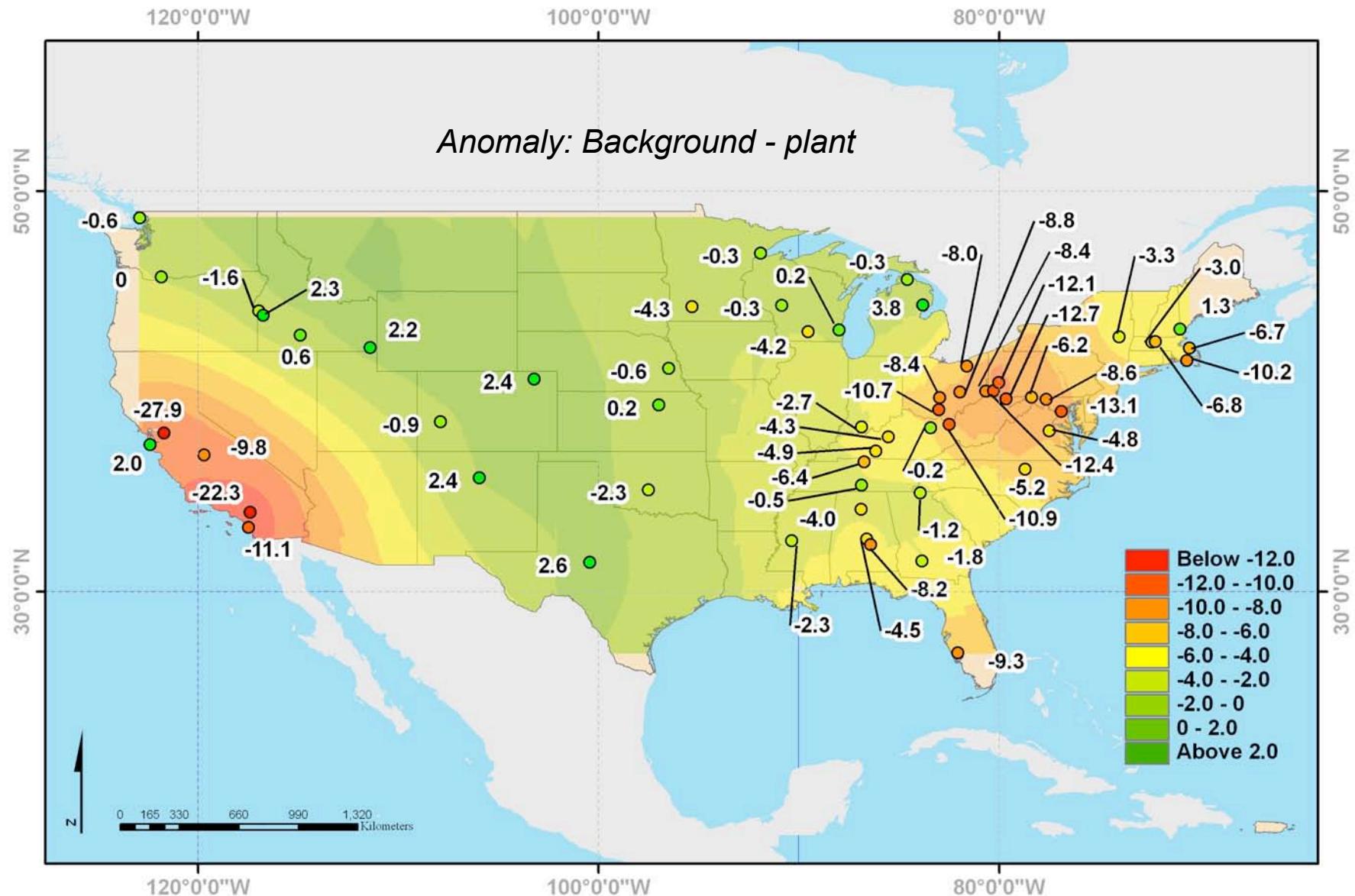
Stable carbon isotopes of CH₄ in the LA Basin



The isotopic composition of plants as bioindicators



The spatial pattern of corn radiocarbon content



Modified from Hsueh et al. 2007 Geophysical Research Letters v.34

The spatial pattern of corn radiocarbon content

- Hsueh et al. 2007 also used the MATCH atm transport model and CASA to model $\Delta^{14}\text{C}$
- Measured and modeled $\Delta^{14}\text{C}$ agreed within 1 ‰

Winter annual grasses (weeds) as bioindicators

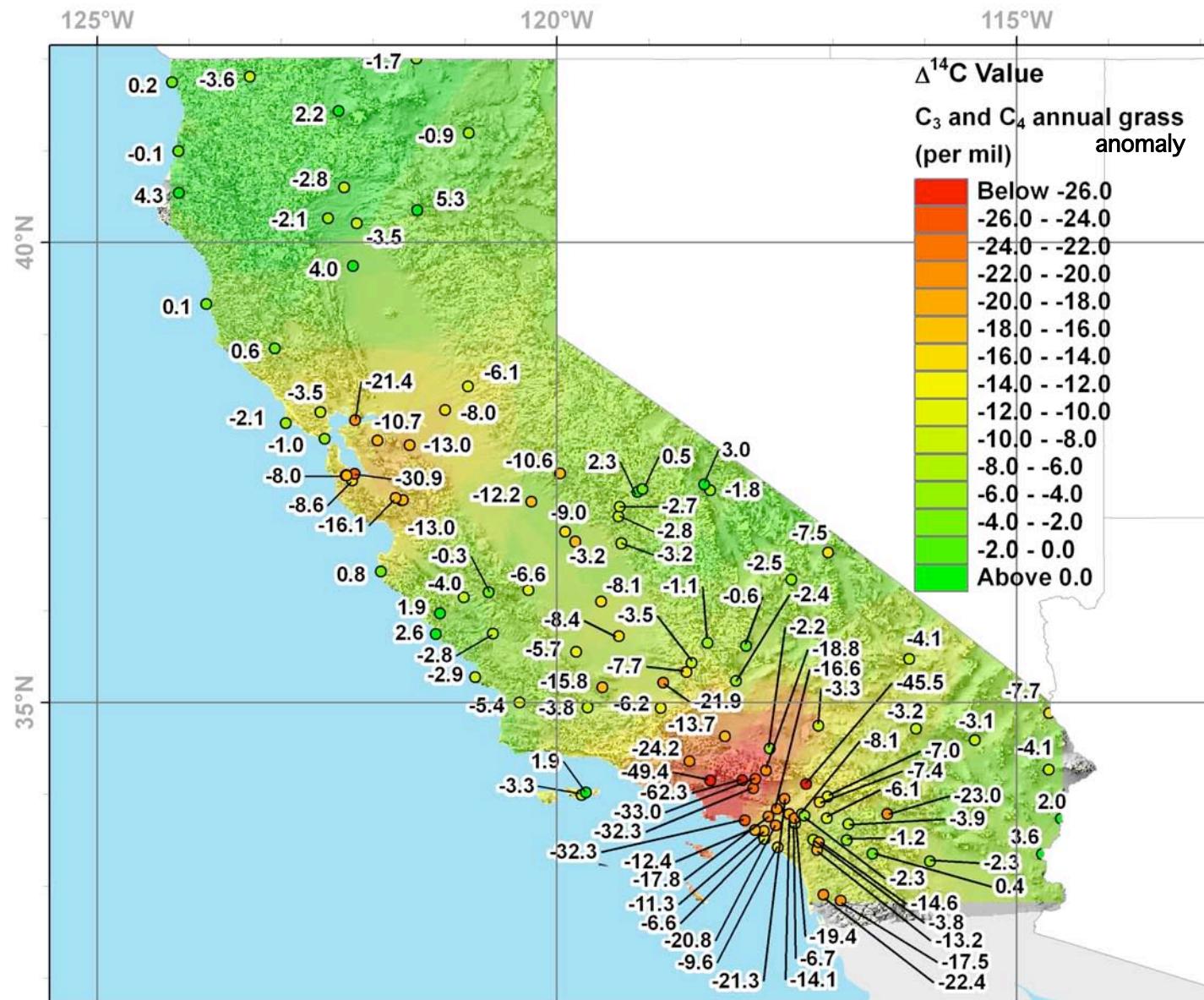


Palmdale, CA



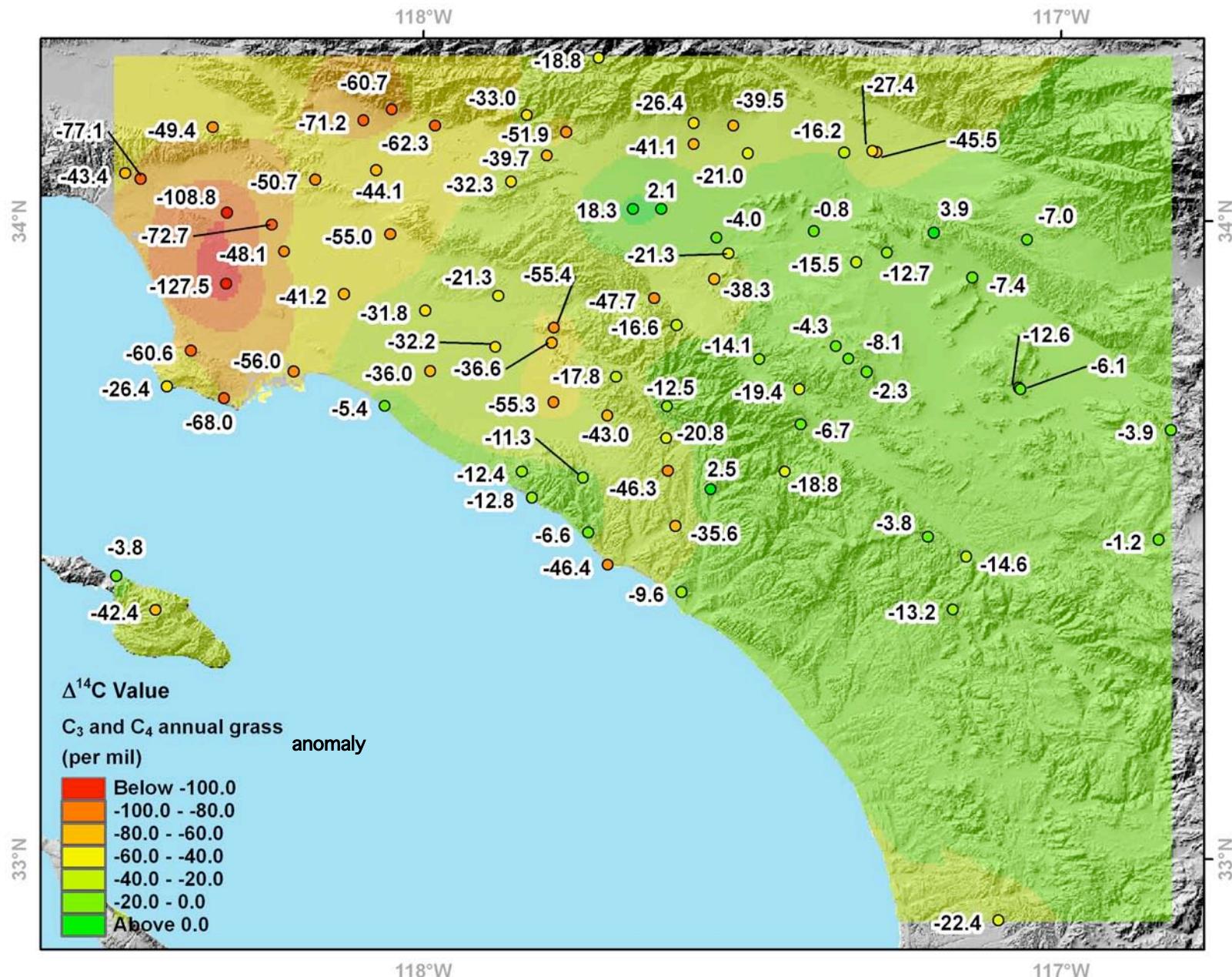
Cantil, CA

The spatial pattern of weed radiocarbon content



Modified from Riley et al. In press JGR Biogeosciences

The spatial pattern of weed radiocarbon content



Conclusions

- Stable and radiocarbon isotopes of CO_2 can be used for source attribution
- This method will likely be useful for CH_4 and N_2O , but work is still in progress
- Plant isotopes integrate over longer periods and reflect the fossil fuel CO_2 in the atmosphere